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SYNFUEL PRODUCTION AS AN ECONOMIC FARM ENTERPRISE

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Synfuel production has been forwarded as a partial solution to U.S. liquid fuel needs. Among the various synfuel alternatives, alcohol from crops (principally corn) and a diesel oil substitute from oilseed crops (such as sunflower) are the only near term possibilities that can provide significant quantities of liquid fuels before the 1990's. While most of the synfuel production will come from large commercial plants, farmers are keenly interested in fuel from on-farm biomass production units. They forsee another farm enterprise that will provide both additional income and a secure, stable source of fuel for carrying out agricultural production tasks in a timely manner. Therefore, farmers are asking questions concerning the techniques of energy production and seriously weighing the alternatives. However, farmers are also asking management questions, such as "How will farm energy production affect other farm enterprises?" and "How will farm energy production affect the farm's labor and capital requirements?" In short, farmers want some assurance that not only is on-farm synfuel production technically feasible but also that it can be integrated into the total

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farm business. Clearly, the answer will not be uniform for all farms since each farm has a unique mix of production, management and financial resources.

This paper describes a synfuel decision model (computer program) that will assist farmers and farm advisers in making an economic assessment of potential synfuel production on individual farms. It will be accessible to individuals and groups on remote terminals and/or micro-computers. This generalized mathematical programming model allows users to describe their specific farm situation as an input to the program. The program then estimates the impacts of synfuel production on their particular farm, providing answers to specific questions surrounding the integration of synfuel production into their present operation. Since farm production activity possibilities are region specific, this model incorporates two energy feedstocks sources that are potentially available in Ohio and the central and southern part of the Corn Belt generally. One is corn. The other is sunflower which is grown as a double crop following winter wheat. The model can be adapted to add other energy feedstock alternatives.

On Farm Energy Production Systems

In small-scale operations, 190 or lower proof alcohol is typically produced. To produce anhydrous (200 proff) alcohol, azeotropic distillation using benzene is required. This process is best performed by large operations and is not considered as a viable on-farm option.

One bushel of corn will yield between 2.2 and 2.5 gallons of 190 proof ethanol. After removing the alcohol, 240 pounds of stillage remain for each bushel of corn. The stillage can be filtered and pressed to produce 37 pounds of wet distillers grains (WDG) and 203 pounds of wet distillers solubles (WDS). These products must be fed immediately or can be dried to produce 11 pounds of dry distillers grains (DDG) and 6 pounds of dry distillers solubles (DDS). Distillers dried grains with solubles (DDGS) has a 27 percent protein content as well as a longer storage life than the wet stillage and, as such, can be sold or stored and used as a livestock feed. Production of DDGS however, requires additional energy expenditure. DDGS may be fed in liberal quantities to ruminants (dairy and beef cattle), but high fiber and incomplete amino acids limit consumption levels for hogs and poultry. The ethanol produced from corn can be used on-farm in pure form or sold. On-farm use is often limited since most farm machinery is diesel powered. The model allows the sale option only.

Unlike alcohol, which requires a biological/chemical procedure, sunflower oil production is a simple mechanical process. It can be easily adapted to any scale and does not involve the high capital requirements of alcohol production. The seeds should be dehulled (optional) and pressed. The oil should be filtered. The nonalcohol nature of sunflower oil eliminates the alcohol processing problems of government regulations, large water requirements, environmental impacts, danger of explosions, and large energy requirements. Thus, oil production is more technically feasible for on-farm production.

Sunflower oil is used only as a diesel fuel replacement. Tests are still being conducted to determine the best usage of the oil - in pure form or combined with diesel fuel. The viscosity of the oil requires either mixing with diesel or butanol or a modification of fuel filtration systems. Between 85 and 105 gallons of oil can be produced per acre of sunflowers. After extracting the oil, a meal is left which has a 45 percent protein content. The meal can be used for beef, swine, poultry, and other livestock. If the seeds were not dehulled, the meal has a high fiber content and can only be used for ruminants. The model allows sunflower oil to substitute for on-farm uses of diesel fuel.

Crop and Livestock Production Systems

Energy crop production and use must compete favorably with existing farm enterprises. The common inputs are land, labor, capital, and energy. The crops considered are corn grain, corn silage, soybeans, wheat, hay and sunflowers. Pasture land is also permitted but is assumed to be land not suitable for other crop enterprises.

Three types of livestock are permitted: swine, beef cattle, and dairy cattle. Livestock are included to demonstrate the usage of the by-product of synfuel production. Poultry can only use small amounts of the by-product so are not included in the model. Feed requirements for all livestock are in corn equivalents with a minimum protein constraint. The manure is recycled back to the cropland and a cost and energy value is associated with that. All livestock are sold.

Five types of swine production can be analyzed: (1) blocked farrow to finish, (2) continuous production farrow to finish, (3) blocked feeder pig production, (4) continuous feeder pig production, and (5) finishing production. All will be high investment, confinement systems. The blocked production systems have fluctuations in labor requirements and are used when the main farm activity is crop production with large labor demands during certain periods. Continuous production systems are found on farms more heavily involved in swine production or with more labor available. Beef cattle can be cow-calf or beef feeder enterprises. Only one type of dairy production is considered.

Model Formulation

The model objective is to determine the optimal mix of farm enterprises to maximize profit. A linear programming model is used. The requirements for a linear programming model are: there must be alternative courses of action, the alternatives must be interrelated through some type of restriction, there must be an objective which is explicitly stated, and the variables must be linearly related.

Within the model there are 138 activities. Each crop has multiple activities to accurately represent the timeliness of operations. For example, corn may be planted in three different time periods in the spring and harvested in three different time periods in the fall--a total of nine different corn planting-harvesting activities. Also, land preparation activities and post-planting operations (spraying and cultivating) may be done in several time periods, thus a total of 17 corn production activities are used in the model.

The model has 137 constraints. Land may be owned, rented, or some combination of the two. Maximum and minimum production levels may be established for each crop and livestock species to restrict production levels. Labor constraints restrict the labor available in each time period. Labor can be comprised of farmer's labor plus hired labor minus any of the farmer's labor hired out. Hired labor is assumed to be only 80 percent as productive as the farmer's labor. Tractor hours are a scarce resource only during planting and harvesting periods.

Land must be prepared for planting corn and soybeans sometime between harvesting in the fall and planting in the spring. Constraints which may restrict land preparation are land, labor, field hours, and tractor hours. Corn and soybeans are planted during several periods. Planting an acre utilizes an acre of prepared land which cannot be used again until after harvesting. Labor hours per acre and equipment working rates are constant for all planting periods. Post-planting operations are performed two and four weeks after planting, and all acres of corn and beans planted must have the post-planting step. This operation utilizes labor, field hours, and tractor hours.

Harvesting of corn and soybeans uses field hours, tractor hours, and labor hours. Combines may harvest corn or beans, and custom harvesting can be used when there is a shortage of labor or combine hours.

All beans harvested are sold immediately. Corn can be sold, dried and sold, or stored for usage in alcohol production or for livestock feed. The yield of each crop varies by planting and harvest date. Storage loss is accounted for by increasing the quantity required for the various uses. Harvested corn moisture is based on the harvest date, and all corn is dried to 15.5 percent moisture

Corn silage uses the same prepared land and post-planting operations as corn grain. Silage can have own or custom harvesting and must be fed on the farm.

The other crops are handled in less detail. Wheat may be produced as a single crop or double cropped with soybeans or sunflowers. The wheat crop is sold or used as livestock feed. The double cropped soybean crop is treated exactly as the regular bean crop except that land preparation, planting, and post planting all take place in the same time period. Sunflowers are handled much as beans with the output going into sunflower oil production.

Each livestock system has minimum feed requirements in terms of corn equivalents and amount of protein. The feed ingredients (corn, wheat, oats, soybean meal, corn gluten feed, stillage, DDGS, and sunflower meal) are all evaluated for feed content. No land is required for swine and only pasture is required for cattle, since it is assumed that the livestock will use land not normally cropped.

Alcohol production requires corn, labor, and energy. Any other inputs (i.e., land and water) are assumed to be available in sufficient quantities to meet production needs. Due to the expected presence of livestock and high capital costs, alcohol is produced at a fairly constant level for the entire year. The alcohol is sold and the stillage may be fed wet to livestock or dried for sale or feed.

Sunflower oil production is not required to be a year-round operation. The feed by-product nature and capital requirements do not dictate continuous production. The meal can be sold or fed to livestock. Labor, sunflowers, and energy are the inputs of most importance.

Interfacing the User and Model

The successful application of this model would allow the user direct access with minimum interference by others. Advances in remote terminal and micro-computer technologies permit individual users to own terminals or micro-computers. Or users in a county may have access to one machine through the Cooperative Extension Service.

In either case substantial effort is required in designing the proposed computer model. An interactive computer program is needed which prompts the appropriate input from the user. The computer model must be "idiot proof" with the user needing to know nothing of model design. It must clearly specify the needed input data, sort the data for that which is plainly erroneous, find a solution, and print the results in an easily understood fashion.

Technology has advanced rapidly in developing convenient, low-cost remote terminals. They have become lighter weight, less costly, and more reliable, and have higher transmission speeds. Capabilities such as internal memory for temporary storage, editing, and retrieval of data allow the user to manipulate data before transmission to a large computer system.

An emerging technological change is the use of micro- and mini-computers. With an investment of a few thousand dollars, it is possible to have a fairly extensive computer processing facility. Computer models, such as the one discussed in this paper, could be loaded on micro- or mini-computers. The user would receive the programs via diskettes or tapes that would serve as storage devices for the programs. To use the model, the user would load the diskette or tape, type a statement to load the program on the micro- or mini-computer, and then run the computer model.

Finally, there is the possibility of "down-loading" programs to micro- or mini-computers. The central main frame computer would remain the place where programs are stored and cataloged. Clients would dial the main computer, select their program, and down-load it to their own machine. The program could then be run on the mini- or micro-computer, using relatively little telephone connect time and central computer capacity. This alternative also would allow the micro- or mini-computer to serve simply as a terminal for some programs requiring the large computational capacity of the main frame computer.